Illegal, Unreported and Unregulated (IUU) Fishing: A Whitepaper

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OUTLINE

1. INTRODUCTION

This whitepaper characterizes the status of Illegal, unregulated, and unreported fishing (IUU), the philanthropic community's current efforts to help reduce it, and potential opportunities for the Packard Foundation to become more actively engaged. The paper was drafted between March and June 2015 by Bernd Cordes and California Environmental Associates, following a combination of desk research and a handful of select interviews.[1]

What is IUU?

Illegal, unregulated and unreported fishing (IUU) refers to fishing activities that do not comply with regional, national, or international fisheries conservation or management measures. To simplify, IUU consists of three distinct but related elements:

- **Illegal** fishing refers to fishing activities that violate national or international laws. In practical terms, illegal fishing can include fishing without a license, under-reporting catches, keeping undersized fish, fishing in closed areas, using prohibited fishing gear types, illegally transshipping fish, or violating any other law.
- **Unregulated** fishing refers to fishing activities in areas where there are no applicable national, regional, or international conservation or management measures. Unregulated fishing is not illegal *per se* and can either occur in an unmanaged fishery within a country's Exclusive Economic Zone (EEZ) or on the high seas, such as when fishing is done by vessels that are un-flagged or flagged to a State not party to international conventions.
- **Unreported** fishing refers to fishing activities that have not been properly reported. Unreported fishing is not necessarily illegal or unregulated, though it can be either. Unreported fishing is often associated with poor data collection or weak fisheries management; lack of reporting can also conceal illegal activity.

While it is well known that IUU is a major barrier to effective fisheries management, the exact scale of IUU is difficult to quantify. Available evidence suggests that at least 20 percent of wild landings (11-26 million tons of fish) are Illegal or Unreported, representing annual financial losses on the order of $10-24 billion. Developing countries are disproportionately affected by illegal fishing as they often have fewer means to safeguard their offshore resources. If one also adds Unregulated landings—which are also disproportionately found in the Global South—to the dollar figures above, the estimates increase substantially.

Why is addressing IUU important?

Reducing IUU fishing is important for several reasons. To start, IUU undermines efforts to effectively and sustainably manage fisheries. Undetected fishing leads to poor and ineffective management decisions, and often hinders efforts to protect populations of the most vulnerable and valuable species. The sale of IUU fish in the marketplace can distort free and fair competition for legal fishermen trying to practice their trade responsibly, and ultimately lead to very real disincentives for better management of fish resources at sea.

From a market perspective, the IUU fish trade can pose significant liabilities for companies in the supply chain. Taking the necessary steps to prevent illegal fish from entering a market in the first place might simply be an easier route than certification or fully vetting the supply chain with sustainability criteria well after a fish has been pulled from the sea. Recognizing this, early adopters in the seafood business community are starting to implement voluntary measures to improve transparency, to support a handful of global initiatives and domestic policy reforms intended to deter IUU fishing, and to increase traceability in the seafood supply chains and reduce fraudulent labeling.

[1] See the Appendix for the list of interviewees.

IUU has also been associated with an array of crimes, including drug smuggling and human trafficking. Several recent high-profile cases in Thailand and Indonesia linking IUU fishing to human rights and labor abuses have given authorities another good reason to take action on IUU fishing.

From a fiscal perspective, IUU is associated with lost government revenue in that it is not taxable, and is often linked to incursions by foreign fleets that routinely circumvent permitting and license fees. Preventing illegal activities is squarely in the self-interest of most fishing nations.

Finally, combatting IUU can help ensure access to markets. In the last few years, import controls in Europe aimed at preventing trade in IUU fish have had substantial ripple effects on fisheries management across the Global South. In countries such as Indonesia, fighting illegal fishing (illegal foreign fishing vessels, in particular) has proven to be a politically powerful and dramatic effort.

Combatting IUU fishing and the legal, financial, social, and reputational risks it poses—to the common good and private industry alike—can galvanize a broad cross-section of actors to move towards more transparent, better-managed fisheries. As a result, the fight against IUU provides a strategic entry point for philanthropic efforts to promote sustainable seafood and sound fisheries policy.

Fishing trawlers transship their catch to a reefer off the cost of Guinea. IUU fishers often prefer to transship their catch at sea rather than in port to avoid being caught by authorities. © Environmental Justice Foundation (EJF)

2. ADDRESSING IUU: CURRENT EFFORTS, KEY PLAYERS, CHALLENGES, AND OPPORTUNITIES

IUU can be categorized according to whether the fishing occurs within national waters or offshore in international waters. A wide range of activities intended to reform Unregulated and Unreported fisheries are currently underway within the Exclusive Economic Zones of individual countries. Meanwhile, attention to the damage done by Illegal offshore and international fishing—traditionally an area that has received little attention—has increased in recent years. This paper provides an introduction to IUU initiatives across a range of geographies. It focuses, in particular, on four cross-cutting strands of work that have the potential to measurably reduce IUU fishing across multiple countries. Those four strands are:

(1) The use of new trade policy and import controls in key markets to deter IUU;
(2) The development and application of new technologies to detect and combat IUU fishing in offshore and nearshore environments;
(3) The establishment and ratification of new policies and practices, such as the Port State Measures Agreement, to address IUU in international waters and in the ports where fishing vessels bring their products; and
(4) The work being done in individual countries to reduce IUU fishing in nearshore, largely-domestic fisheries.

For each of the four strands, we characterize the state of current efforts, key actors in the field, challenges to the application of this work, and potential opportunities for the Packard Foundation to become more directly engaged.

2.1 TRADE POLICY AND IMPORT CONTROLS

CURRENT EFFORTS AND KEY PLAYERS

One of the most frequently cited ways to effectively deter illegal fishing is to deny market access for IUU fish. The two primary ways to do this are: (1) Establishing and then ensuring effective implementation of trade-related, anti-IUU regulations in major import markets (e.g., the European Union, United States, and Japan); and/or (2) Helping the biggest seafood buyers and retailers in the world institute rigorous procurement standards that complement those policies. There is a growing consensus within the conservation community that these trade-related efforts are very important for triggering better fisheries management by exporting countries, but it is less clear and there is less evidence that they can effectively prevent illegal fisheries or fraud. That said, several countries have undoubtedly already made specific changes to their fishing practices in response to recent EU trade sanctions and the threat that the US will shortly follow suit.

EU IUU Regulation

The EU currently has the most aggressive anti-IUU regulation of the major importing regions. Entering into force in 2010, the regulation requires that all fisheries products imported into the EU be accompanied by a catch certificate with information about the species, catch location, fishing vessel, date of capture, and any trans-shipments that have taken place. In cases where a product is suspected as IUU, EU Member States can refuse to import the fish.

While the enforcement of these provisions at the point of entry varies considerably, one of the most powerful and high-profile elements of the EU regulation is a provision that allows banning imports or port access from countries or vessels

that don't take clear public action to address IUU fishing. Since the inception of the law, the EU has issued yellow cards[2] to several countries and red cards[3] – actual trade sanctions – to countries that are not doing enough to improve fisheries management and prevent IUU. The threat of these trade sanctions has had a powerful effect on exporting countries. For example, in 2013, the EU issued the Republic of Korea a "yellow card," and shortly after, the US placed Korea on a public list of suspected IUU countries. The combined pressure from two large market countries brought about previously unforeseen action by multiple agencies in South Korea, including the Parliament, the Ministry of Foreign Affairs, and the President, to update its distant water fisheries laws.

According to an Environmental Justice Foundation (EJF) report, while the EU's IUU regulation has "the potential to significantly impact the economic and political drivers behind IUU fishing," there are still some weaknesses in terms of implementation. Concerns include a lack of transparency with its electronic data-gathering system, insufficient information sharing, inconsistent implementation amongst EU member states, and a persistent inability to accurately distinguish legal from illegal fish.

EJF's overall recommendations on how to improve implementation of the EU IUU regulation include:

- *Increasing transparency*: Currently, no public information is available on rejections of IUU shipments by member states. Spain, considered one of the most proactive implementers of the law, has only rejected .04 percent of its imports, a tiny fraction which is, nevertheless, said to represent 50 percent of all seafood imports rejected by EU member states.
- *Increasing consistency*: Some member states have not rejected any imports despite importing significant amounts of seafood from outside the EU. A lack of uniformity in applying the regulations could lead to the rerouting of IUU product to less regulated ports or into the EU via containers, which are not considered fishing vessels and are not subject to the same scrutiny.
- *Developing a centralized, online data system*: The current paper-based catch certificate system is vulnerable to fraud and limits member states' ability to communicate and share data in real-time.
- *Improving identification of IUU fish*: The EU needs to improve the ability of vessel flag States to accurately validate catch certificates using centralized data and surveillance systems. The EU should also actively support the development and implementation of a Global Record of fishing vessels, as well as the universal and mandated use of IMO (International Maritime Organization) numbers as Unique Vessel Identifiers.

The primary non-profit organizations that work on IUU policy in the EU are EJF, Oceana, the Pew Charitable Trusts (Pew), and World Wildlife Fund (WWF).

US IUU Regulation

In June 2014, the White House established a Presidential Task Force, co-chaired by the departments of State and Commerce, to recommend a comprehensive framework of programs to combat IUU fishing and seafood fraud in the US. With input from several groups, including a WWF-organized Expert Panel, the Task Force released recommendations in December 2014, followed by an action plan in March 2015. The action plan includes measures to expand domestic partnerships to detect IUU fishing, strengthen enforcement, and develop a traceability program to track seafood from harvest to entry into the US. The Task Force's action plan also outlines how the US will work internationally to address IUU fishing, including through the Trans-Pacific Partnership (TPP) currently being negotiated with 11 other countries.[4] While the Task Force does not recommend replicating the EU carding system, it agreed to

[2] Yellow carded countries: Belize, Cambodia, Fiji, Guinea, Panama, Solomon Islands, South Korea, Sri Lanka, Thailand, Togo, Tuvalu, and Vanuatu

[3] Red carded countries: Belize, Cambodia, Guinea, and Sri Lanka

[4] TPP is a free trade agreement currently under negotiation between the U.S., Australia, Brunei, Canada, Chile, Japan, Malaysia, Mexico, New Zealand, Peru, Singapore and Vietnam.

much of what the Expert Panel recommended, creating what one interviewee called "a breakthrough, threshold moment."

Though a substantial step in the right direction, some are concerned that the Task Force's action plan lacks comprehensiveness, at least initially. The Task Force will ensure that traceability pilots for a handful of high risk products will be implemented, and will then explore the potential to expand the program to include all seafood imports. While the Task Force and other senior US government officials suggest that traceability will eventually be required for all US seafood imports, real political opposition remains from powerful seafood import associations and industry laggards who predict increasing costs to their operations. Continued strategic advocacy will, therefore, be needed to ensure an outcome where traceability requirements are universally applied. Those interviewed for this white paper stressed the urgency of acting while there is momentum and before a new administration takes office.

The Presidential Task Force's key next steps are:

- By October 2015, define the specific information that will be required for seafood products to enter the US, and identify which species this system will first apply to (based on the likelihood of that species being caught illegally).
- By September 2016, finalize rules to collect additional information on species at risk.
- By December 2016, identify the steps needed to expand the program to all seafood entering the US, taking into careful consideration input from relevant stakeholders, as well as experiences from the first year of implementation.
- Throughout the process, determine how information within the traceability system – including data on specific species, geographic origin of caught fish, and means of production – can be shared with consumers.

The primary non-profit organizations that work on IUU policy in the US are Oceana, Pew, and WWF.

Voluntary Market Import Control and Supply Chain Efforts

Progress is being made not only on US and EU policies, but also through voluntary market-based actions that fishing companies, processers, major buyers, and others are taking to identify and deny market access to illegal fish. These efforts are important because they promote and facilitate traceability in select markets and build momentum for national-level regulations. For example:

- Certification schemes like those administered by the Marine Stewardship Council (MSC) and the Aquaculture Stewardship Council (ASC) now have chain of custody protocols in place to help trace fish back to their source.
- The International Seafood Sustainability Foundation (ISSF) requires its members to source seafood from vessels that have 100% observer coverage, participate in a global vessel monitoring system, and have an IMO number.
- EJF and others recently documented and publicized clear and widespread human rights abuses in segments of the fishing industry, and have been able to connect those abuses to specific fisheries and supply chains of retailers, thus increasing pressure on corporate actors, such as Walmart, to take action.
- NGOs have helped the largest North American and European retailers adopt sustainable procurement practices and increase transparency around their sourcing; this includes the Global Food Traceability Center—a US public-private partnership with sponsors from industry, academia, and the conservation community—that coordinates efforts to ensure alignment and interoperability between global seafood traceability systems and US regulations.

Funders

Funding for these initiatives comes from a number of sources. Oceans 5 has been the primary source of support for promoting IUU trade measures, with Oak and Moore foundations also making important contributions (note that Oak is a member of Oceans 5, but also makes direct grants in support of anti-IUU fishing activities).

Specific to EU-related trade policy and import controls, since 2014, Oceans 5 has provided $1.4 million annually to support EJF, Oceana, Pew, and WWF for their work on the EU card system and improvements in implementing EU regulations. That Oceans 5 funding will last at least until mid-2017. It is unclear at this point what the Oak and Moore foundations will choose to support over the next few years.

Regarding US policy development and implementation, Oceans 5 has also been a leading source of support, providing $1 million annually over the last three years to a coalition including WWF, Oceana, Pew, the Marine Fish Conservation Network (MFCN), and Greenpeace. As this funding comes to an end this year, Oceans 5 is currently considering whether to renew these grants or not. In addition, the Moore Foundation is currently funding a two-year, $6 million traceability pilot focused on seafood retailers, their supply chains, and progressive industry actors to help them comply with and support US traceability policy efforts. Moore Foundation staff hopes to get board approval for a comprehensive portfolio focused on traceability and IUU in May 2015.

CHALLENGES

- **Cohesiveness amongst a multitude of players**: Seafood traceability programs led by governments, companies, and NGOs are often varied and developed without the coordination needed to effectively stop IUU.
- **Limited funds relative to size of the problem**: Several interviewees cited funding gaps and too few sources of funding as a real constraint, particularly with regard to helping draft and implement robust anti-IUU trade policies in the biggest seafood markets. The shortfall will be greater if Oceans 5 opts not to continue funding US IUU policy work.
- **Uncertain political will and effectiveness of IUU trade policies**: As stated, it is unclear whether the US IUU regulations are comprehensive enough to affect real change. It is also unclear whether developing similar legislation in Japan, the world's third largest seafood market, is possible (something Packard Foundation is now exploring). Robust legislation is, of course, important to close legal loopholes allowing illegal vessels to continue their operations, but stringent legislation is only effective insofar as it is accompanied by the political will and technical capacity to consistently enforce rules at sea and in ports.
- **Unequal burden on local fishermen**: Traceability and import regulations can have negative, and some believe disproportionate, economic and financial impacts on small-scale fishermen in developing countries, depending on the affordability of traceability systems and the strength and fairness of fisheries management in those countries.

OPPORTUNITIES

- **Improve implementation of the EU's IUU policy:** Help government and non-government partners maintain momentum behind new IUU regulations, avoid backsliding, and increase consistency across EU countries. The Oceans 5 engagement is intended to be temporary and it's unclear what additional work will remain after their support ends.
- **Improve policies in countries affected by EU sanctions:** In South Korea and, potentially, other yellow or red card countries (such as Fiji, where Packard Foundation has a longstanding interest), invest in initiatives that test the effectiveness of new IUU laws while also maintaining pressure on the government to enforce those laws. In South Korea, for example, EJF, WWF, and Greenpeace have been engaging with the government to strengthen controls

on the distant water fleet. These efforts are not currently well resourced. Packard could expand efforts to other countries (e.g., Thailand, Sri Lanka, etc.) where IUU trade measures have opened the door for change.

- **Ensure follow-through on US anti-IUU fishing regulations:** Ensure that NGO and industry partners have the resources to partner with the Presidential Task Force, and to push to make its new traceability rules both binding and enforceable. Continue to engage the industry and public sentiment behind the need to reduce IUU fishing. A coalition working on these issues already exists and may benefit from additional financial support, particularly if Oceans 5 does not continue funding IUU work.
- **Improve cross-nation coordination of IUU policies:** Ensure that the world's largest seafood markets – the US, the EU, and Japan –coordinate their respective efforts to deter IUU fishing.
- **Encourage other key markets to apply stricter anti-IUU fishing rules**: Government agencies and NGOs in the US and EU can work together to encourage other major seafood markets (particularly Japan and China) to adopt complementary IUU policies.
- **Anti-IUU Campaigns**: The NGO community could engage on this issue through targeted campaigns that shed light on illegally-caught seafood, seafood fraud, and human rights abuses in seafood supply chains, thus opening political windows for anti-IUU policy reform and enforcement.

An armed unit of the South Korean Coast Guard arrests Chinese fishermen who have been fishing illegally in South Korean waters. Very few countries can afford effective fisheries surveillance and enforcement at sea. Photo Credit: Dong-A Ilbo/AFP Image Forum/Getty Images

2.2 ANTI-IUU TECHNOLOGY DEVELOPMENT AND APPLICATION

CURRENT EFFORTS AND KEY PLAYERS

Technology is a critical component in efforts to reduce IUU fishing and to increase transparency and traceability in both near shore and offshore environments. A variety of recent technological advances make significant reductions in IUU

fishing a possibility in the near term, including (i) the increased computing power of handheld devices; (ii) the proliferation of user-friendly GPS applications; (iii) the increased capacity for "big data" storage, sharing, and analysis; (iv) the variety and improved durability of drones and low maintenance radar stations; (v) the accessibility and accuracy of satellite imagery; (vi) continuous improvements in onboard digital cameras and recorders; (vii) expanded use of Automated Information Systems (AIS) and Vehicle Monitoring Systems (VMS); and (viii) advances in DNA testing.

In general, AIS and VMS are critical to efforts to combat IUU. IUU experts generally agree that remote sensing technologies such as AIS and VMS are needed on all commercial fishing vessels in order to detect, track, and prosecute fishers that are operating in closed waters or otherwise practicing Illegal fishing. IUU experts also agree that AIS and/or VMS can be used to accurately track offshore and near shore fishing that might be technically *legal*, but is Unregulated and/or Unreported. Of course, those technologies are only as good as the political will and the capacity of the people and institutions whose job it is to implement and utilize them. The use of AIS and/or VMS—technologies that have existed for many years—is still not universally mandated by fishing nations and Regional Fisheries Management Organizations (RFMOs).

In fact, most of the technology—not just AIS and VMS—needed to reduce IUU fishing already exists. But wider use is limited by, among other things, the cost of satellite imagery and of installing equipment on smaller vessels, by gaps in the interoperability of data sharing software and hardware, and by limited numbers of individuals adequately trained in the use of the tools available to them. That being said, cost is becoming less of a barrier: most of the technologies referred to in this section are steadily becoming more affordable even as their effectiveness improves. For example, surveillance costs have, by one well-informed estimate, already fallen by about 40% in Galapagos National Park, and installing and using AIS and VMS on large offshore commercial fishing vessels is no longer prohibitively expensive.

Dozens of initiatives are underway right now using various technologies to combat IUU at different spatial scales in the Atlantic, Pacific, and Indian Oceans. The two most prominent international-NGO-led initiatives are the Pew Charitable Trust's Ending Illegal Fishing Campaign and Oceana's Global Fishing Watch, both of which have a heavy technology component. Other, more localized monitoring technology is being used by the Wildlife Conservation Society and WildAid to address smaller-scale, near shore Unregulated and Unreported fisheries. All of these efforts are profiled below.

Pew's Ending Illegal Fishing Campaign

The Ending Illegal Fishing Campaign is probably the most comprehensive NGO-led effort to reduce IUU fishing. Pew and its partners are (a) identifying useful, existing technologies and actively applying them to improve surveillance and data gathering; (b) identifying gaps in existing hardware and software, and then developing new databases and data-sharing software to fill those gaps; (c) negotiating with companies and governments to drive down the cost of technological fixes and, in particular, the costs of satellite imagery and data collection/sharing; and (d) training customs officials in the use of those new technologies. They believe that appropriate and widespread use of technology will help shape policy and help create the hard evidence for prosecution of illegal fishing.

At the center of the 10-year Campaign is a partnership with the Satellite Applications Catapult (SAC), a British private innovation and technology company. Pew and SAC work directly with governments committed to reducing IUU fishing in their waters. They combine satellite monitoring and imagery data with fishing vessel databases—databases that rely on Unique Vehicle Identification numbers (UVIs)[5] as well as AIS and VMS—to detect illegal fishing off the coasts of, for

[5] The International Maritime Organization keeps a global registry of UVI numbers for commercial boats, including fishing vessels. The UVI number assigned by the IMO stays with the vessel during its entire life, regardless of name, flag and ownership changes.

example, southeast Africa, Chile and Palau.[6]

Oceana's Global Fishing Watch Campaign

Oceana is partnering with Google and SkyTruth to implement Global Fishing Watch, a "technology platform that uses satellite data [which is reliant upon AIS] to inform the public about overfishing." Google contributes its cloud computing, software programming, and data management expertise; SkyTruth makes the hardware and skills available to access reliable satellite imagery and other data; and Oceana contributes ocean science, media skills, and the legwork needed to make data publicly available.

Global Fishing Watch is a campaign, based upon state-of-the art technology, that aims to provide actionable data to specific constituencies that have the ability to change fishing rules and behavior. This data is provided at low or no cost. An online prototype for Global Fishing Watch has been developed and tested using fishing vessel data from 2012 and 2013, but the tool has not yet gone live and, therefore, has not yet been directly linked to action at sea or in fishing ports. When it does go live, Oceana, SkyTruth, and Google believe it will help convince governments to expand the mandatory use of AIS, improve traceability of fish from sea to consumer, and verify a vessel's catch data for constituents like the Marine Stewardship Council, customs agencies, and progressive private sector retailers.

Both Pew's Ending Illegal Fishing Campaign and Oceana's Global Fishing Watch have at their core an interest in using technology to gather and disseminate actionable data to make fishing more transparent. Pew and Oceana are, in principle, interested in all fishing, but both are especially focused on illegal offshore fishing within the boundaries of an MPA, an EEZ, or on the High Seas. Having said that, they are not redundant campaigns and can fairly be described as complementary. Pew's focus is squarely on a dozen-or-so specific countries and government agencies—especially off the coast of southeast Africa and in the Pacific—that have volunteered to participate and have committed to reducing IUU fishing, to enforcing MPA boundaries, and to seeking targeted assistance for: (1) training dockside customs officials in how to use newly available technologies, and senior customs officials in how to enforce new fishing standards, like the Port State Measures Agreement (see next section); (2) creating a global record of fishing vessels on a software platform that is universally accessible, (3) managing large-scale MPAs, especially in the Pacific (Pitcairn, Palau, Easter Island, etc.); and (4) sharing information—potential evidence—across specific, collaborating governments and RFMOs that enable prosecution and critical analyses about the damage done by illegal fishing efforts, and therefore helps to have IUU fishing recognized as an international crime.

Oceana, on the other hand, seeks to gather and share global, geospatial data on where illegal fishing is occurring and what practices are used with an unlimited audience—fishing industry, government agencies, public activists, seafood consumers, et.al.—and to share that data at no cost to the user. Oceana does not believe transparent data alone will lead to policy change, but it does believe it is a prerequisite to, for example, (1) build advocacy campaigns that pressure uncooperative governments and RFMOs to mandate AIS systems on commercial vessels; or (2) enable e-mail alerts to fisheries managers when a blacklisted vessel enters their EEZ, or to the MSC when fishing vessels regularly turn off their AIS systems.

Technology and Unregulated and Unreported Near Shore Fishing

Generally speaking, better management of near shore fisheries is more about rule-based norms than it is about technological fixes. Unregulated fishing can be addressed by drafting and implementing gear restrictions, spatial limits, seasonal closures, and the like, and Unreported fishing by mandating data gathering and creating consistent, user-friendly formats for it on boats and on the docks. Once these measures are taken to improve near shore fisheries, then

[6] Palau's government is considering a recent $30 million offer of assistance—along with two patrol boats—from the Japanese government to help pay for monitoring and surveillance if, indeed, the Palau government enacts a law that would place 80% of its EEZ under no-take status.

technology can play a much more effective role in monitoring and enforcement.

Onboard monitoring and surveillance equipment, such as AIS and VMS, can be valuable to small-scale fishing operations, in part because many smaller fishing vessels, despite their size, go very far offshore, and are often out for multiple days. For these smaller fishing operations, the proportional cost of installing and maintaining AIS/VMS is marginally higher than for large commercial vessels, but over time prices continue to fall and durability continues to increase, and AIS/VMS equipment has significant safety value for these small-scale operators. The same can be said for onboard cameras and other remote observation tools, which are already in everyday use or being tested off the coast of Alaska, in the Bahamas, in Madagascar, and many more locations. While satellite imagery and tracking is usually less practical and too cost prohibitive for most near shore surveillance, other existing technologies—such as land-based radar and stationary, high-powered cameras; patrol boats with GPS-trained crews; watchtowers and night goggles; and even limited range drones—can be quite effective when used in combinations appropriate for local conditions.

In Belize, Wildlife Conservation Society, the Fisheries Department, and local MPA authorities collaborate to design and implement a national enforcement plan. Together, they use low-tech SMART enforcement software that spatially tracks fishing effort and violations in otherwise hard-to-regulate areas. SMART was developed as a terrestrial tool often used, for example, in southern Africa. Its application to the marine environment in Belize is the first of its kind. WCS is coupling this with a pilot test of Pelagic Data System's VMS equipment, which is a relatively low-cost on board sensor specially designed for smaller vessels that can monitor a boat's location, fish storage temperature, and catch methods. Each cell-connected device is about $100. It tracks data and automatically downloads it once it is within reach of a cell signal (the signal is usually lost after 5 nm from shore), which allows for either continuous tracking (when near a cell tower) or data downloading when a boat comes ashore. WCS is also conducting a pilot test of drones that cost $2,500-$3,000 each and that have a range of about 20 miles. But most importantly, all of this has as its foundation a mix of basic capacity building for local fisheries officials and prosecutors, baseline fisheries assessments using low cost methods, and reform of the vessel licensing system for local fishermen and their boats.

Similarly, WildAid has helped create an A to Z enforcement plan in the Galapagos Islands with the assumption that, where technology is concerned, simple is better. WildAid and local government agencies gather both offshore and near shore data by way of land-based radar stations, GPS, and on-board AIS and VMS systems, then feed the information to boat patrol teams and the Navy for enforcement. But for near shore, artisanal fishing surveillance, WildAid and its partners in the Galapagos increasingly rely on radar and high-powered land-based cameras that cost about $15,000-$20,000 each, are stationed on "vigilance posts" (i.e., towers that can sometimes cost as much as the cameras themselves), and that can "see" 6-10 nm out from shore. Because the cameras include software and an algorithm (created by Cohu, a San Diego-based company) that can self-detect potential violations, they don't necessarily need a person to be monitoring them at all times or pouring over old footage to identify irregularities. In WildAid's experience thus far, GPS/AIS/VMS surveillance methods work for monitoring reserves in near shore locations, but for multiple use zones, people, binoculars, and cameras are often more effective for real-time monitoring.

In the case of both WildAid and WCS, the techniques they are using in Belize and the Galapagos are also being adapted in other parts of the world where they work on improving unregulated, unreported, but otherwise *legal* near shore fisheries in places like central and eastern Indonesia, Madagascar, and Ecuador.

The Ending Illegal Fishing Campaign, Global Fish Watch, and near shore fisheries enforcement in Belize and the Galapagos are just four of the more prominent, NGO-led initiatives currently underway to reduce IUU fishing. Other NGOs working on this issue or on IUU-related technologies include:

Environmental Justice Foundation
Pacific Islands Fisheries Forum Agency
World Wildlife Fund
TRACE Wildlife Forensics Network

In addition to—and often in collaboration with—the NGO-led initiatives, there are several companies actively developing and applying technologies that can help reduce IUU fishing, including:

Aero Environment	FishpopTrace
Archipelago Marine Research	Liquid Robotics
DigitalGlobe	Sea-Trak
Eurofins	Shellcatch/Pelagic Data

Appendix 3 includes a brief description of the above-mentioned NGOs and companies, and the activities each is working on.[7]

CHALLENGES

- **Insufficient political will:** IUU experts all seem to agree that until the use of UVIs, AIS and/or VMS systems are required on all commercial fishing vessels, illegal and unreported fishing will continue, and regulating fish catch will remain very difficult. And until AIS and/or VMS use is made mandatory, most of the other technologies that can help end IUU fishing (satellite imagery and locational data, land- and water-based radar, vessel databases that can be shared digitally and wirelessly, etc.) will be of limited utility. Political will is needed not only to put these technologies in place, but also to establish the legal/prosecutorial procedures and penalties to make full use of the evidence fisheries agents and dockside customs officers collect with the technology they have.
- **Prohibitively high costs for some technologies:** As of today, the price tag for using some technologies (e.g., satellite imagery, cameras, patrolling) remains prohibitively high for many governments and NGOs, particularly if (a) using the technologies over prolonged periods of time, and (b) deploying technologies that were developed for at-sea military purposes and that have not yet made the transition to commercial use. Cost is one reason why monitoring and surveillance are often neglected, even for high profile MPA designations. For satellite imagery, in particular, to become a broadly useful tool for surveillance and enforcement, the current cost and process of acquiring it needs to be re-negotiated. On the other hand, the cost of installing and using AIS and/or VMS on a boat is generally affordable; that is, cost is usually less of an impediment than a fishing vessel not wanting to reveal to its competitors where it is catching fish, or reveal to enforcement agencies where it might be fishing without permits.
- **Limited consistency and coordination in sharing data:** A significant reduction in IUU fishing requires accurate data collection, sharing, and analysis. The pieces of software and hardware exist to gather the data, but three things need to happen to make that data more useful: (1) AIS and/or VMS systems need to cover much more of the global fish catch than is currently covered (currently only about 3,000+ boats); (2) agreement is needed on the precise bits of data to be gathered and stored in a common database (customs officers and fisheries agents need the fisheries equivalent of a universal financial audit format), and (3) agreement is needed on the software platforms that can get, in a cost effective and consistent way, surveillance imagery and locational data, boat numbers, catch histories, and trip logs into the hands of officials who can then use it to identify high risk vessels, prioritize dockside vessel inspections, or deny port access when illegal fishing is suspected. IUU experts are in general agreement that

[7] This paper does not include descriptions of U.S. government—or other government—programs that are related to IUU fishing and technologies that can be used for enforcement and surveillance, though there are many. For a sense of what those programs are, one can look into NOAA's VIIRS Nighttime Lights database, the U.S. Coast Guard's Shiprider program, the U.S. Department of Defense's SeaVision program, etc.

the best way to catalyze such coordination is for more governments to truly commit to and ratify the Port State Measures Agreement.

OPPORTUNITIES

- **Make the use of AIS and/or VMS mandatory:** Support 2-3 organizations with the ability to lead, and coordinate between themselves, targeted advocacy campaigns that will convince governments and RFMOs to mandate the use of AIS and/or VMS equipment on, first, large off shore commercial vessels and, when that is done, on smaller near shore commercial vessels. The technology exists and the financial costs of using it are not prohibitively high. Rather, it is a matter of political will to change use of AIS/VMS from a voluntary practice to a mandatory one. The campaigns could target progressive fishing nations, countries that have ratified the PSMA, RFMOs, or some combination thereof.
- **Develop a Common Format Global Vessel Record:** Support 2-3 organizations with the ability to lead, and coordinate between themselves, the development of software platforms that will result in a common format database with fishing vessel data that can be publicly accessible and easily shared. Such a database, when coupled with wider use of AIS/VMS by commercial vessels both big and small, might just make it possible within the next decade to establish a system whereby an enforcement officer will be given a vessel's unique identification number and, with a few clicks, gain access to accurate information about that vessel's true identity, whether it has been involved in illegal fishing, whether to permit or deny it port entry, or whether to begin gathering evidence and preparing legal proceedings against the boat and its owners.
- **Demonstrate that Enforcement and Surveillance Technologies are Effective and Valuable:** Few examples exist outside of the US and Europe where comprehensive monitoring, traceability, surveillance, and enforcement have been proven effective (or cost effective) for a large MPA/Reserve network, for a particular fishery, or for a full supply chain from source to plate (like Chilean sea bass). More examples are needed to prove such technologies can be used in a way that is credible, cost effective and valuable socially, economically, and environmentally. Pew's Ending Illegal Fishing Campaign and WWF's traceability work are designed to result in a handful of such examples. Enforcement in the Galapagos National Park already comes close to standing out as a successful pilot. And Oceana's Global Fishing Watch campaign could essentially shame bad government and industry actors into better performance and behavior by increasing transparency across the board. Yet the careful selection of 5-7 fisheries, supply chains and/or MPAs, and the thoughtful design of a monitoring, surveillance and enforcement protocol for the whole portfolio, could go a long way to prove the concept. A portfolio approach could be used to test the technologies that are most cost effective under different conditions, to train people in the use of new technologies, and to bring the cost of technology down.

  For an MPA portfolio, one might consider, among other criteria:
  - Size (large, small, etc.); Habitat (near shore, off shore, ridge to reef, etc.); Proximity to human population centers (remote reef or atoll, within sight of shore, etc.); Primary governance and authority (national park, traditional reserve, multiple use, etc.); Objective (biodiversity conservation, fisheries management, cultural value, etc.); and/or Location (all within one geographic region or across multiple regions, etc.)

  For a fisheries portfolio, one might consider, among other criteria:
  - Species (tuna, snapper, etc.); Range (highly migratory, limited range, etc.); Market (international, domestic, mixed, etc.); Habitat (near shore, off shore, mixed, etc.); and/or Size of boats in a fleet (less than or more than 20-30GT, etc.)

- **Make direct investments in the development and application of IUU-related technologies:** While there are no obvious or immediate needs for large investments in new technology development, there might be opportunities to mix grant and Program-Related Investments to:
    - Refine and field-test the effectiveness of existing technologies. For example, Sea-Trak is working on camera technology that would allow boats to be on the water for 2-3 days at a time without the battery failing, and that would be able to transmit data to on shore stations even when up to 20 nm at sea
    - Help drive down the cost to NGOs of purchasing satellite imagery, to assist AeroEnvironment as it tries to produce a less expensive underwater automated system (about $200,000 right now for three vehicles), or to invest in Cohu's attempts to devise less expensive infrared cameras for night surveillance.

Unique and permanent vessel identification numbers can help cut down IUU. Photo credit: Wikimedia Commons

2.3 Offshore fisheries governance and the Port State Measures Agreement

CURRENT EFFORTS AND KEY PLAYERS

In addition to import controls and the application of technology to fight IUU, there is a well-established effort to increase the governance of fisheries on the high seas, which have historically fallen in a legal gray area in terms of jurisdiction and management responsibility.

The high seas, or international waters, are the open waters of an ocean or a sea beyond the limits of territorial jurisdiction of a country, falling outside the boundaries of any country's Exclusive Economic Zone. The Convention on the High Seas was one of four international treaties created at the United Nations Conference on the Law of the Sea (UNCLOS) in 1958.[8] It has been revised many times since 1958, but its fundamental intent is to establish international norms governing the high seas, where no single country's laws otherwise take clear precedence. As of 2013, 63 states had ratified the Convention.

UNCLOS asserts that ships sailing the high seas are generally under the jurisdiction of the flag of the state they fly under. An abiding challenge in encouraging stronger management on the high seas is that thousands of vessels are now registered under "flags of convenience" from countries with weak oversight, such as Panama and Liberia. However, UNCLOS also states that, "when a ship is involved in a *criminal act*, such as piracy, any nation can exercise jurisdiction

[8] The US finally signed the oft-revised UNCLOS Agreement in 1994, and generally treats it as a legitimate arbiter of rules on the high seas, though it has never ratified the treaty.

under the doctrine of universal jurisdiction." Universal jurisdiction allows individual states to claim criminal jurisdiction over an accused vessel regardless of where the alleged crime was committed and of the accused's nationality.

This distinction is important in that, as of today and despite its name, IUU fishing is not considered an international crime in the way that, for example, international drug trafficking is. This makes monitoring, surveillance, interdiction and, especially, prosecution of IUU fishing on the high seas more difficult, despite the well-established and widespread use (though not universal use) of assigned Unique Vessel Identification numbers for industrial fishing boats, as well as the use of voluntary electronic on-board tracking systems for vessel safety (i.e., AIS and VMS). It also makes enforcement difficult for illegal fishing within EEZ boundaries because it represents an exploitable loophole (fishermen can claim to have caught fish on the high seas rather than within an EEZ, and thus not subject to the laws applying within an EEZ.)

Port States Measures Agreement (PSMA)

One important attempt to remedy the legal ambiguities at sea is the UN's 2009 Agreement on Port States Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (PSMA). Where UNCLOS is about the actions of boats offshore and beyond easy visual surveillance, the PSMA covers what happens when those vessels land their catch. Critically, the PSMA's provisions apply to all boats and fish that come into port, regardless of whether they have been fishing in the high seas or an EEZ. The Treaty "requires parties to exert greater port controls on foreign-flagged vessels," thereby closing loopholes and eliminating some incentives for illegal and unreported fishing. The PSMA's premise is straightforward: If ports where fish are landed are the choke points for the fishing industry, then make it much more difficult to find a port-side buyer for illegally caught product.

Countries that agree to implement the PSMA are obligated to:

1. Designate which ports foreign-flagged vessels may seek to enter.
2. Restrict port entry and access to port services (including for the landing, transshipment, processing and packaging of fish) by vessels that have been engaged in IUU fishing, particularly those on the IUU vessel list of a regional fishery management organization (RFMO).
3. Conduct dockside vessel inspections in designated ports and meet minimum standards for inspections, inspection reports and inspector training.
4. Share information, including inspection results, when evidence of IUU fishing is found.

There is general agreement amongst those trying to reduce IUU fishing that ratification and implementation of the PSMA, in combination with better surveillance technology and mandatory AIS and VMS use, is a critical prerequisite for combatting IUU on the high seas. PSMA's heavy emphasis on improving credible documentation can simultaneously reduce problems associated with both Illegal and Unreported fishing. The PSMA will come into force when 25 countries ratify it. Thus far, only eleven have: Chile, the European Union, Gabon, Mozambique, Myanmar, New Zealand, Norway, Oman, Seychelles, Sri Lanka, and Uruguay. The US Senate ratified the Agreement in April 2014.

The PSMA attempts to bring together disparate rules and norms on offshore fishing, some new and some old, under one consistent framework. While momentum behind the PSMA may be building (e.g., seven of the eleven PSMA ratifications occurred since mid-2012), few groups are directly involved in promoting the PSMA. Those that are include:

- **FAO**, which is the international body responsible for the PSMA standards-setting, ratification and application. FAO also manages the Global Record of Fishing Vessels, an international database of industrial fishing vessels that contains the UVI of all known industrial fishing boats, as well as information on their ownership, flag state, history, and fishing authorizations.

- **Pew**, whose Ending Illegal Fishing campaign includes a strong push to increase the number of countries ratifying the PSMA and, just as importantly, is implementing training programs for port officials and others whose job it is to enforce the laws and provisions established by the PSMA. Pew also commissioned an important 2011 gap analysis comparing the port state measures RFMOs have themselves established for their members, and the provisions set forth in the FAO's PSMA. Pew's analysis describes very specifically how the protocols of 10 RFMOs fall well short of the standards established by the PSMA.
- **Greenpeace**, which maintains an IUU blacklist database compiled from publicly available official registries of IUU vessels and companies. Greenpeace also published last year a report on the extent of IUU fishing by South Korea's distant water fishing fleets, and is one of the few NGOs closely tracking both legal and illegal fishing in Melanesia (i.e., Papua New Guinea, Solomon Islands, etc.), where IUU is particularly problematic.
- **Oceana**, which is actively fundraising to start a campaign—as part of its Global Fishing Watch program—promoting PSMA ratification and PSMA protocol training for government officials.

To our knowledge, no private foundations have invested substantial funds in promoting PSMA ratification or PSMA-related training for fisheries agents and customs officials. This is, in part, because the type of government-to-government collaboration ratification and training requires is usually considered more appropriate for bi-lateral and multi-lateral donors (e.g., the way in which the European Fisheries Fund can be used to implement activities that improve traceability).

CHALLENGES

- **High cost and complexity of campaigns around ratifying the PSMA**: For the PSMA to take effect, 14 more countries need to ratify it. While adherence to the PSMA's provisions is critical to fighting IUU on the high seas, successful campaigns to encourage countries to ratify the PSMA will require a well-crafted strategy and a lot of persistence. Encouraging ratification will also require careful adherence by private foundations to lobbying rules in target countries. Whether or not to focus limited resources on the wider adoption of an international treaty or on practical, day-to-day management is a difficult calculation.
- **Limited capacity to implement the PSMA:** Even if the PSMA secures 25 ratifications, implementation will require significant financial resources and collaboration between governments, the industry, and NGOs. Each jurisdiction will need to train enough people in ports to effectively and consistently administer the provisions and obligations attached to the PSMA; without wide adoption and associated capacity building, IUU vessels will simply sail to "friendly" ports where enforcement is lax.

OPPORTUNITIES

- **Develop an IUU list:** Provide the funding for and a venue in which lead stakeholders, who are already either managing an IUU watch list or considering developing one (e.g., Greenpeace, Pew, FAO, NOAA, Norway's Directorate of Fisheries, et. al.), can coordinate a common, user-friendly, and easily shared and updated database format identifying suspected illegal fishing vessels.
- **Build local capacity to administer the PSMA's rules:** The rules and regulations behind the PSMA are clearly stated, and an adaptable training protocol to help port states adhere to those rules and regulations has been developed. Until now, however, only limited resources have gone into the inevitable next step of training local dockside officers, customs officials, and fisheries managers. Pew has started to do so by working directly with early-adopter nations, but much more needs to be done. As a first filter, one could look at the countries that have already ratified the PSMA, and then begin a dialogue as to whether and how each might require technical training assistance. The next tier would be those countries that are actively considering PSMA ratification, or at least some

components of it. Even in the absence of full ratification, training local officials in administering its rules and regulations has value in its own right—not only are skills transferred, but the training programs themselves can help build momentum and even demonstrate to skeptical governments that meeting PSMA's standards is both feasible and valuable.

- **Work with the Indonesian government and NGO community on PSMA training:** The next filter for extending PSMA-specific training programs are those countries where an opportunity exists now, and where the Foundation has experience and interest. Indonesia is one of those countries. Not only does the Packard Foundation have a longstanding and prominent profile there, it also has a Capacity and Leadership training budget dedicated to Indonesia (alongside two other countries). Indonesia presents a window of opportunity to build on the momentum created behind recent—often controversial—efforts to crack down on illegal foreign fishing, to reform management of Indonesia's massive near shore fisheries, to modernize Indonesia's port infrastructure, and to secure Indonesia's place in the region as a responsible and politically and commercially influential maritime nation. NGO partners could, for example, promote Indonesia's ratification of the PSMA as part of a larger fisheries policy initiative. Even if Indonesia doesn't ratify the PSMA, there will be value in working with the government to set up a practical training program for fisheries officials using the PSMA protocols. The Foundation has been investing in a similar initiative targeting MPA management for the past 5 years in Papua Province.

2.4 REDUCING IUU IN DOMESTIC FISHERIES

CURRENT EFFORTS AND KEY PLAYERS

This paper has thus far focused on efforts to reduce offshore IUU fishing within EEZ boundaries but at considerable distance offshore, or on the high seas where international rules and organizations matter most. With few exceptions, this paper has focused less on domestic IUU fishing in near shore environments.[9] There are several reasons for this:

1. Most IUU-related philanthropic, NGO, and government-led initiatives thus far have focused on offshore fisheries that have high commercial value on the international market, and not on near shore, artisanal fishing.
2. It is often politically easier to focus on illegal fishing by foreign-flagged boats than it is on illegal or unregulated fishing done by domestic fishermen near the communities where they live.
3. While illegal fishing certainly does happen nearer to shore in many countries around the world, the main challenge with near shore fisheries often has less to do with illegality (the "I") than it does with a glaring lack of cohesive regulations or reporting requirements on fish catch (the "UU").

In many countries in the Global South, near shore fisheries are, in effect, open access. There are a variety of reasons this is the case: existing regulations are well-intentioned but poorly designed; there are limited resources or a lack of political will to enforce the fishing rules that exist; effective management to prevent overfishing in near shore environments is not considered an immediate problem; etc.

Whatever the reason, *de facto* open access in near shore environments leads to little or no reporting, a sense of very loose or no regulatory restrictions on fishing practices by local fishermen, a flexible take on what does or does not constitute illegal fishing when a boat is locally-registered, and, ultimately, an incomplete understanding of the damage this unconstrained fishing does to fish populations, habitats, and the commercial viability of the local fishing economy.

In short, near shore fisheries for domestic markets probably have more of an impact on oceans than offshore IUU fishing, but because the problem with near shore fisheries has more to do with the Unreported and Unregulated and less with Illegality, it is often left out of the discussion around IUU-related agendas. That said, in almost every major fishing nation, there is some effort to improve fisheries – i.e., to fix the Unregulated and Unreported fisheries where reform is still needed, and to put in place new laws that clarify the Illegal. Many of those efforts are led or co-managed by NGOs and local government agencies, and funded by private foundations or bi-lateral programs. These efforts are a mainstay of the Packard Foundation's work in the Western Pacific and in Mexico, even if they aren't explicitly framed around IUU. Ongoing work in Belize and Ecuador has already been mentioned, above; below are several more examples of what is happening in some high profile fishing nations, as well as the ideas and approaches that are being used and that could be exported to other locations.

- **Brazil** recently launched a national plan to eradicate illegal fishing with an investment of $16.8 million, aiming to guarantee the sustainability of its domestic fishing sector. The initiative includes meetings with fishing communities to raise awareness of illegal fishing, as well as incentives to owners of vessels who use legal practices. Relevant ministerial agencies are expected to improve cooperation and to commit a total of 1,000 public servants to efforts combating IUU fishing. IUU fishing by foreign vessels will be affected by the plan, but the primary focus is the one million or so Brazilians involved in the artisanal and industrial fishing economy. Ultimately, the plan targets thousands of near shore fishing vessels without licenses, using forbidden gears, or operating during closed seasons.

[9] Near shore fishing is difficult to define, but it generally refers to fishing done by crews of 1-5 individuals on boats smaller than about 10 GT, within the continental shelf or 12 miles from shore, and usually for no more than 1-3 days at a time.

Rare, with Bloomberg Foundation funding, leads one of the more high profile efforts in the country, but a handful of other local groups have been working on these issues using smaller amounts of money from foundations and bi-lateral agencies.

- **Ecuador** is working with WildAid to establish and enforce a network of coastal MPAs and fishing grounds, a plan that includes due attention to reporting requirements, new regulatory guidelines, and appropriate surveillance technologies, similar to what has already been done in the Galapagos National Park.

- **Indonesia** is currently getting more attention on IUU fisheries reform than just about any other country. In the past year alone, the government has by edict or new legislation prohibited trawling, banned trans-shipment of fish at sea, temporarily suspended new fishing licenses for any vessels constructed abroad, confiscated and blown up over 60 mostly foreign fishing vessels, established an IUU task Force and an IUU branch of the Supreme Court, and banned shark and ray fishing. Aside from the ban on sharks and rays, however, little of the national-level activity has yet had bearing on near shore fisheries. TNC, WWF, WCS, CI, Rare, EDF and a handful of local NGOs are actively involved in initiatives to reform near shore fisheries by improving reporting and encouraging and experimenting with new regulatory mechanisms, all of which are intended to have a profound effect on both near and off shore fisheries management, even though they do not necessarily consider themselves IUU initiatives. The Packard, MacArthur, Cargill, and Walton foundations have all been important sources of support, along with USAID, the World Bank, and other bi-lateral and multi-lateral agencies.

- **Mexico**'s government recently took steps to limit its own fishing industry's IUU fishing in the United States' EEZ, particularly where poaching of *totoaba*, an endangered species that is protected under CITES and the US Endangered Species Act, is concerned. Mexican fishing boats have been apprehended by the U.S. Coast Guard in the Gulf of Mexico, prompting Mexican officials to verify vessel registrations and permits, expedite the installation of AIS on all Mexican boats, strengthen the Mexican Navy's surveillance and patrolling efforts, and analyze the feasibility of establishing a fishing exclusion zone near the maritime boundary between the US and Mexico. In the Gulf of California and, to a lesser extent, on the eastern Gulf side of Mexico, a relatively large cohort of local and international NGOs have been working to reform the "UU" aspects of near shore fisheries management, mostly with funding from the Packard, Walton, Marisla, and Sandler foundations.

- **The Philippines**, following a "yellow card" warning from the EU in 2014, enacted new anti-IUU legislation in 2015. A technical working group is currently drafting the implementing rules and regulations for the legislation, which include significant fines for illegal commercial fishing and poaching, and a requirement that all Philippine-flagged fishing vessels have onboard Monitoring, Control, and Surveillance Systems. A good deal of optimism surrounds the reforms, but in order for the law to be properly implemented, strong enforcement needs to follow. The legislation doesn't apply to very small fishing vessels operating close to shore, and won't have a direct impact on most of the country's 500+ small-scale marine sanctuaries and no-fishing reserves. It is likely to put at least some limitations on medium-sized boats operating nearer to shore off of Mindanao or Palawan, and in the vicinity of larger protected areas like Tubbataha National Marine Park.

- **Thailand** has reacted to recent, well publicized documentation of labor abuses in the fishing industry by requiring reports on labor conditions, the use of GPS-based monitoring devices, and mandatory licensing and registration of all vessels over 30 meters. These changes mostly target boats that operate offshore. As for near shore fishing, Thailand has historically done very little to improve management, and very few conservation organizations or donors, aside from USAID many years ago, have made it a priority. It remains to be seen whether the EU IUU pressure will trigger a reform in the antiquated national fisheries law.

- **South Africa** is beginning to make some much-needed reforms in its offshore fishing industry and, nearer to shore, there are ongoing efforts to reduce lobster and abalone poaching, including a revision to the small scale fisheries policy that re-allocates resources and partial management responsibilities to local communities.

- **Vietnam**, with World Bank support, is in the process of revising its fisheries management plan and establishing co-management responsibilities for coastal communities that utilize nearshore fisheries.

CHALLENGES

- **It is difficult to address Unregulated and Unreported fishing activities.** Near shore fisheries are often more negatively affected by Unregulated and Unreported fishing than strictly Illegal operations. Devising and reforming regulations and reporting systems is usually a longer, less dramatic, and more circuitous prospect than identifying illegal fishing where clear laws already exist.
- **Near shore fisheries can be diffuse and expensive to reform:** Reforming fishing practices by tens of thousands or even millions of local fishers—who depend on fishing for their livelihoods and contribute to local food security—is politically more difficult than targeting illegal fishing by outsiders. Because local fishermen often fish for the less-financially-lucrative domestic market, there is less of a commercial incentive or argument for reform. It is often difficult to address a chronic over-capacity of boats and an under-capacity of dedicated skills and financial resources in local coastal settings, particularly with limited foundation funds.
- **Science is poor:** Reasonably rigorous stock assessments are a necessary pre-condition for the creation of well-informed and meaningful regulations and reporting systems. Very few near shore fisheries have been assessed anywhere in the world, and fisheries managers have been slow to adopt data-poor stock assessment techniques.

OPPORTUNITIES

Opportunities in this section should be assessed on a country-by-country basis, since the interventions are necessarily local and vary by place. The normal playbook for foundations includes a range of policy development, advocacy, field work, market engagement, and capacity building. In general, the first step is to better understand the state of fisheries where catches are not reported (i.e., Unreported) and build a case for limits on fishing where access is *de facto* open (i.e., Unregulated). A few cross-cutting approaches for consideration include:

- **Invest in the development and testing of stock assessment techniques for commercially valuable, domestic-market fisheries**, and do so in countries where it is clear that there is a government-led fisheries reform movement that will immediately benefit from the data.
- **Invest in third party economic and policy analyses on fisheries reform**, and do so in countries where it is clear that there is a government-led fisheries reform movement that will immediately benefit from the analyses.
- **Invest in a series of tests of appropriate enforcement and surveillance technologies and the skills to use them**, and do so in countries where there is already a network of small scale coastal MPAs whose management is focused on the health of local fisheries (as opposed to biodiversity as a primary objective) and food security (e.g., Madagascar, Federated States of Micronesia, Palau, Belize).

3. CONCLUSION

Overall, there is a great deal of enthusiasm and recent momentum around efforts to address IUU. Yet philanthropic funding is comparatively sparse, and a handful of NGO actors (EJF, Oceana, and Pew) are repeatedly playing the main leadership roles. It will take an interconnected and well-coordinated set of efforts to effectively deter illegal fishing globally – this is by no measure an easy problem to solve. However, efforts to specifically address Illegal fishing (whether through import controls, the PSMA, or technology) appears to be a promising approach because it inevitably leads national governments to also put to the test ways of reducing Unregulated and Underreported fishing. Ultimately, reducing IUU fishing complements both in-country fisheries reform and the promotion of sustainable seafood.

To summarize, the main opportunities identified above include:

Trade Policy and Import Controls

- **Improve implementation of the EU's IUU policy:** Help government and non-government partners maintain momentum behind new IUU regulations, avoid backsliding, and increase consistency across EU countries. The Oceans 5 engagement is intended to be temporary and it's unclear what additional work will remain after their support ends.
- **Improve policies in countries affected by EU sanctions:** In South Korea and, potentially, other yellow or red card countries (such as Fiji, where Packard Foundation has a longstanding interest), invest in initiatives that test the effectiveness of new IUU laws while also maintaining pressure on the government to enforce those laws. In South Korea, for example, EJF, WWF, and Greenpeace have been engaging with the government to strengthen controls on the distant water fleet. These efforts are not currently well resourced. Packard could expand efforts to other countries (e.g., Thailand, Sri Lanka, etc.) where IUU trade measures have opened the door for change.
- **Ensure follow-through on US anti-IUU fishing regulations:** Ensure that NGO and industry partners have the resources to partner with the Presidential Task Force, and to push to make its new traceability rules both binding and enforceable. Continue to engage the industry and public sentiment behind the need to reduce IUU fishing. A coalition working on these issues already exists and may benefit from additional financial support, particularly if Oceans 5 does not continue funding IUU work.
- **Improve cross-nation coordination of IUU policies:** Ensure that the world's largest seafood markets – the US, the EU, and Japan – coordinate their respective efforts to deter IUU fishing.
- **Encourage other key markets to apply stricter anti-IUU fishing rules**: Government agencies and NGOs in the US and EU can work together to encourage other major seafood markets (particularly Japan and China) to adopt complementary IUU policies.
- **Anti-IUU Campaigns**: The NGO community could engage on this issue through targeted campaigns that shed light on illegally-caught seafood, seafood fraud, and human rights abuses in seafood supply chains, thus opening political windows for anti-IUU policy reform and enforcement.

Technology Development and Application

- **Make the use of AIS and/or VMS mandatory:** Support 2-3 organizations with the ability to lead, and coordinate between themselves, targeted advocacy campaigns that will convince governments and RFMOs to mandate the use of AIS and/or VMS equipment on, first, large off shore commercial vessels and, when that is done, on smaller near shore commercial vessels. The technology exists and the financial costs of using it are not prohibitively high. Rather, it is a matter of political will to change use of AIS/VMS from a voluntary practice to a mandatory one. The campaigns could target progressive fishing nations, countries that have ratified the PSMA, RFMOs, or some combination thereof.

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- **Demonstrate that Enforcement and Surveillance Technologies are Effective and Valuable:** Few examples exist outside of the US and Europe where comprehensive monitoring, traceability, surveillance, and enforcement have been proven effective (or cost effective) for a large MPA/Reserve network, for a particular fishery, or for a full supply chain from source to plate (like Chilean sea bass). More examples are needed to prove such technologies can be used in a way that is credible, cost effective and valuable socially, economically, and environmentally. Pew's Ending Illegal Fishing Campaign and WWF's traceability work are designed to result in a handful of such examples. Enforcement in the Galapagos National Park already comes close to standing out as a successful pilot. And Oceana's Global Fishing Watch campaign could essentially shame bad government and industry actors into better performance and behavior by increasing transparency across the board. Yet the careful selection of 5-7 fisheries, supply chains and/or MPAs, and the thoughtful design of a monitoring, surveillance and enforcement protocol for the whole portfolio, could go a long way to prove the concept. A portfolio could be used to test the technologies that are most cost effective under different conditions, to train people in the use of new technologies, and to bring the cost of technology down.

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  - Size (large, small, etc.); Habitat (near shore, off shore, ridge to reef, etc.); Proximity to human population centers (remote reef or atoll, within sight of shore, etc.); Primary governance and authority (national park, traditional reserve, multiple use, etc.); Objective (biodiversity conservation, fisheries management, cultural value, etc.); Location (all within one geographic region or across multiple regions, etc.)

  For a fisheries portfolio, one might consider, among other criteria:
  - Species (tuna, snapper, etc.); Range (highly migratory, limited range, etc.); Market (international, domestic, mixed, etc.); Habitat (near shore, off shore, mixed, etc.); Size of boats in fleet (less than or more than 20-30GT, etc.)

- **Make direct investments in the development and application of IUU-related technologies:** While there are no obvious or immediate needs for large investments in new technology development, there might be opportunities to mix grant and Program-Related Investments to:
  - Refine and field-test the effectiveness of existing technologies. For example, Sea-Trak is working on camera technology that would allow boats to be on the water for 2-3 days at a time without the battery failing, and that would be able to transmit data to on shore stations even when up to 20 nm at sea
  - Help drive down the cost to NGOs of purchasing satellite imagery, to assist AeroEnvironment as it tries to produce a less expensive underwater automated system (about $200,000 right now for three vehicles), or to invest in Cohu's attempts to devise less expensive infrared cameras for night surveillance

Fisheries Governance and the PSMA

- **Develop an IUU list:** Provide the funding for and a venue in which lead stakeholders, who are already either managing an IUU watch list or considering developing one (e.g., Greenpeace, Pew, FAO, NOAA, Norway's

Directorate of Fisheries, et. al.), can coordinate a common, user-friendly, and easily shared and updated database format identifying suspected illegal fishing vessels.

- **Build local capacity to administer the PSMA's rules:** The rules and regulations behind the PSMA are clearly stated, and an adaptable training protocol to help port states adhere to those rules and regulations has been developed. Until now, however, only limited resources have gone into the inevitable next step of training local dockside officers, customs officials, and fisheries managers. Pew has started to do so by working directly with early-adopter nations, but much more needs to be done. As a first filter, one could look at the countries that have already ratified the PSMA, and then begin a dialogue as to whether and how each might require technical training assistance. The next tier would be those countries that are actively considering PSMA ratification, or at least some components of it. Even in the absence of full ratification, training local officials in administering its rules and regulations has value in its own right—not only are skills transferred, but the training programs themselves can help build momentum and even demonstrate to skeptical governments that meeting PSMA's standards is both feasible and valuable.
- **Work with the Indonesian government and NGO community on PSMA training:** The next filter for extending PSMA-specific training programs are those countries where an opportunity exists now, and where the Foundation has experience and interest. Indonesia is one of those countries. Not only does the Packard Foundation have a longstanding and prominent profile there, it also has a Capacity and Leadership training budget dedicated to Indonesia (alongside two other countries). Indonesia presents a window of opportunity to build on the momentum created behind recent—often controversial—efforts to crack down on illegal foreign fishing, to reform management of Indonesia's massive near shore fisheries, to modernize Indonesia's port infrastructure, and to secure Indonesia's place in the region as a responsible and politically and commercially influential maritime nation. NGO partners could, for example, promote Indonesia's ratification of the PSMA as part of a larger fisheries policy initiative. Even if Indonesia doesn't ratify the PSMA, there will be value in working with the government to set up a practical training program for fisheries officials using the PSMA protocols. The Foundation has been investing in a similar initiative targeting MPA management for the past 5 years in Papua Province.

Reducing IUU in Domestic Fisheries

- **Invest in the development and testing of stock assessment techniques for commercially valuable, domestic-market fisheries**, and do so in countries where it is clear that there is a government-led fisheries reform movement that will immediately benefit from the data.
- **Invest in third party economic and policy analyses on fisheries reform**, and do so in countries where it is clear that there is a government-led fisheries reform movement that will immediately benefit from the analyses.
- **Invest in a series of tests of appropriate enforcement and surveillance technologies and the skills to use them**, and do so in countries where there is already a network of small scale coastal MPAs whose management is focused on the health of local fisheries (as opposed to biodiversity as a primary objective) and food security (e.g., Madagascar, Federated States of Micronesia, Palau, Belize).

APPENDIX 1: FAO'S DEFINITION OF IUU

Illegal fishing refers to fishing activities:

- conducted by national or foreign vessels in waters under the jurisdiction of a State, without the permission of that State, or in contravention of its laws and regulations;
- conducted by vessels flying the flag of States that are parties to a relevant regional fisheries management organization (RFMO) but operate in contravention of the conservation and management measures adopted by that RFMO and by which the States are bound, or relevant provisions of the applicable international law; or
- in violation of national laws or international obligations, including those undertaken by cooperating States to a relevant RFMO.

Unreported fishing refers to fishing activities:

- which have not been reported, or have been misreported, to the relevant national authority, in contravention of national laws and regulations; or
- undertaken in the area of competence of a relevant RFMO which have not been reported or have been misreported, in contravention of the reporting procedures of that RFMO.

Unregulated fishing refers to fishing activities:

- in the area of application of a relevant RFMO that are conducted by vessels without nationality, or by those flying the flag of a State not party to that organization, or by a fishing entity, in a manner that is not consistent with or contravenes the conservation and management measures of that RFMO; or
- in areas or for fish stocks in relation to which there are no applicable conservation or management measures and where such fishing activities are conducted in a manner inconsistent with State responsibilities for the conservation of living marine resources under international law.

APPENDIX 2: INTERVIEWEES

- Chuck Fox, Oceans 5
- Bob Gillett, Gillett, Preston and Associates
- Tony Long, The Pew Charitable Trusts
- Michael Kellerman, The Pew Charitable Trusts
- Marcel Bigue, WildAid
- Steve Trent, Environmental Justice Foundation
- David Schorr, WWF
- Andy Sharpless, Jim Simon, and Jackie Savitz, Oceana
- Dave Balton, US Department of State

APPENDIX 3: KEY PLAYERS

FOUNDATIONS FUNDING EFFORTS TO STOP IUU FISHING

Moore Foundation

Moore is currently implementing a two-year, $3 million/year traceability pilot. The pilot is nearing its end, and the Foundation's Board is now considering a larger, more comprehensive portfolio to build on what has been done and to keep the focus on traceability and IUU-fishing. Pilot grants included:

- FishWise: $634,520 in 2014 to support the creation of traceability principles, at an international and national level, that 1) help companies willing to improve their practices and 2) that ensure coordination amongst stakeholders to reduce redundancy in the multiple traceability initiatives currently underway.
- Institute of Food Technologists: $677,000 in 2014 to complete a cost/ benefit analysis of establishing various levels of traceability in seafood supply chains, and to conduct a return on investment analysis of traceability to individual companies.
- WWF: $1,552,753 in 2014 to develop a strategy and vision for a Global Dialogue on Seafood Traceability that can significantly advance concrete industry and government commitments.

Oceans 5 Alliance

Oceans 5 is a donor collaborative and re-granting mechanism that seeks to expand the global network of large-scale marine protected areas and to constrain over- and IUU fishing. Oceans 5 directly invests in initiatives that strengthen traceability requirements in dominant import markets, including the US and EU. Grantees include Oceana, WWF, MFCN, and Greenpeace, who are working on a variety of initiatives, including:

- EU policy advocacy. EJF, Oceana, Pew, and WWF received $1.4 million/year from 2014-2016 to combat illegal fishing, improve transparency, and improve implementation of IUU Regulation's established by the European Commission and EU Member States.
- US policy advocacy. Oceana, WWF, MFCN, and Greenpeace received $3 million from 2012-2014 (a renewal is now under consideration) to combat IUU fishing and improve accountability for fisheries conservation. The focus is on defining new and enforceable rules in the US to ensure that all seafood is legally sourced and fully traceable "from bait to plate." By helping US government agencies to close one of the world's biggest seafood markets to imports of illegal fish, the project's goal is to shape global standards for seafood traceability and well-monitored fishing.

Oak Foundation

Oak supports anti-IUU initiatives both directly and through Oceans 5. Its direct grants have gone to:

- Oceana: $8,600,000 from 2013-2016 to provide core support for the organization, with some of these funds dedicated to IUU campaigns in the EU.
- Pew Charitable Trusts: $300,000 in 2014 to support Trygg Mat Tracking Foundation's initiative to build a global database of fishing vessels. The database is intended for use by enforcement agencies and other stakeholders needing to verify the identity and history of a fishing vessel, regardless of changes in name, ownership, or flag registry. The database enhances the effectiveness and accuracy of the analysis and investigation of illegal fishing operations.
- Pig Shed Trust: $3,700,000 in 2014 to support the implementation of the 2014 Common Fisheries Policy (CFP) reform (which will, in turn, inform the 2022 CFP reform effort) in order to achieve improved marine ecosystem health and fish stocks in Europe. Pig Shed Trust wants to establish a trusted platform for collaborative philanthropic investment in European fisheries, a platform that will be used to fund projects across Europe that ensure the new elements of the CFP are tried and tested.
- Oceans 5 Alliance: $3,000,000 from 2014-2016 to support Oceans 5 and its ability to make re-grants that expand the global network of large-scale marine protected areas, and that constrain over- and IUU fishing.

Kingfisher Foundation

Kingfisher has been exploring targeted investments that might help reduce IUU fishing in Northeast Asia.

NGOs IMPLEMENTING ANTI-IUU INITIATIVES

Environmental Justice Foundation

EJF, a London-based NGO, exposes global pirate fishing. It implements, for example, a community surveillance project in West Africa to monitor and report on pirate fishing by industrial vessels in inshore areas, and is increasingly using satellite technology to identify illegal fishing further offshore, including illegal trans-shipments of fish at sea. EJF is also focused on potentially criminal labor conditions and human trafficking related to IUU fishing. In 2013, EJF-generated data was used to build the case for "yellow carding" the South Korean and Ghanaian fishing industries by the EU Commission, and EJF is currently gathering data on abuses in the Thai fishing industry. EJF provides film and advocacy training to individuals and grassroots organizations in the Global South, enabling them to document and expose environmental abuses. The organization's Global Fisheries Transparency Project calls for the urgent development of a global record of fisheries vessels and an end to the exploitation of flags of convenience.

FishWise

FishWise is a leader in seafood traceability research. Its past work has highlighted links between IUU fishing, labor abuses, and other related social ills. FishWise also plays an important role in coordinating IUU fishing violations with traceability efforts in North America. FishWise currently partners with retailers—including Safeway, Target, and Hy-Vee—to establish sustainable procurement practices and increase transparency around their sourcing.

The Global Food Traceability Center

The Global Food Traceability Center—a US public-private partnership between industry, academia, and NGO representatives—coordinates efforts to ensure alignment and interoperability of global seafood traceability systems and US regulations.

Greenpeace

Greenpeace maintains an unofficial blacklist on their website to help combat IUU fishing, and advocates for seafood traceability in their tuna and retailer campaigns.

International Seafood Sustainability Foundation

ISSF is a coalition of companies and NGOs aimed at conserving tuna stocks. ISSF requires member companies only buy fully traceable tuna from purse seine vessels that have IMO numbers, have not transshipped at-sea, and have onboard observer coverage. ISSF members are to withdraw product from the marketplace if it is found to be from a vessel on an RFMO's IUU list. ISSF also manages the pro-vessel registry (PVR), a third-party-audited database of vessels that have adopted best-in-class practices including 100% observer coverage, participation in a global vessel monitoring system, obtaining an IMO number, etc.

Marine Stewardship Council

The MSC has established a chain of custody certification capable of ensuring traceability back to the source fishery. The Aquaculture Stewardship Council (ASC) and other farmed certification schemes have similarly demonstrated the viability of boat-to-plate traceability. Companies that use the MSC eco-label must obtain independent chain of custody verification that a given product originated from a certified fishery, which must, in turn, be supported by a certificate held at each link in the chain. Because MSC charges for their eco-label and may be able to obtain more business as IUU fishing decreases, they stand to directly benefit from any success in ending IUU fishing.

Oceana

Oceana is an active policy advocate in the EU and the US on anti-IUU legislation, campaigning for across-the-board transparency and accountability in the seafood supply chain. Oceana is also a leader in exposing seafood fraud, which has generated widespread media coverage and supported their policy efforts. Oceana's 2013 US seafood fraud report tested 1,200 samples from 674 retail outlets in 21 states and found one-third mislabeled according to FDA guidelines. More recent efforts include an exposé on US shrimp (in which Oceana found 30 percent mislabeled), and on local, iconic species such as Chesapeake blue crab (38 percent is mislabeled).

The Pacific Islands Fisheries Forum Agency

FFA is an international membership organization representing 17 Pacific Island nations. Its mandate is to help member states improve the management of and maximize benefits from their tuna fisheries. FFA has fairly generous funding from the European Union and Australia to implement a program anchored by on-board observer

programs (i.e., people and cameras) and VMS-based monitoring and surveillance, especially of purse seine vessels. FFA's program is complemented by Australian and French Air Force flyovers that patrol the waters of French Polynesia and Australia's Melanesian neighbors.

The Pew Charitable Trusts

Pew consciously combines its Ending Illegal Fishing campaign with its existing Oceans Legacy program, thus applying many of the anti-IUU technologies and processes to the improved management of very large MPAs that have been designated in, for example, the Pacific Ocean, including Palau, Pitcairn Island, and Easter Island. Pew is also currently considering whether to design and launch its own program focused squarely on traceability. The program would be an additional part of the overall Ending Illegal Fishing campaign, and would complement the existing campaign components, such as the Virtual Watch Room, Project Eyes on the Sea, and the Ocean Legacy MPA initiative (www.pewtrusts.org/en/projects/ending-illegal-fishing-project).

SkyTruth

SkyTruth's in-house satellite image technology has, as just one example, been applied by Pew to help monitor illegal fishing off Easter Island, and by Oceana to develop its Global Fishing Watch online prototype by providing locational data on thousands of fishing vessels. (skytruth.org)

TRACE Wildlife Forensics Network (and Other DNA Analysis Companies and Government Agencies)

TRACE (a Marine Stewardship Council partner), Applied Food Technologies, the US Food and Drug Administration, the EU's FishpopTrace, Eurofins, Agilent Technologies and many other companies and government agencies conduct DNA analyses themselves, or sell mobile kits that enable DNA testing of fish. DNA testing represents another important data point in the process of tracing what fish are caught where. The price of kits is going down (they usually cost in the hundreds of dollars) while their mobility, ease of use, and accuracy is going up.

WildAid

WildAid has been utilizing various surveillance technologies in different combinations and locations for the last decade. WildAid works with local government and NGO partners on MPA and shark monitoring, and on surveillance and interdiction in Galapagos National park (as mentioned) and Raja Ampat, Indonesia, where they partner with the Misool Resort to monitor and enforce fishing in a Conservation Concession negotiated between the Resort and the local community. WildAid is also building programs in Ecuador; in Bahia Los Angeles, Mexico; and in northern Palau.

Wildlife Conservation Society

In addition to its use of locally appropriate tools to improve surveillance of and reporting on near shore and small scale IUU fishing in Belize, Indonesia, Madagascar and other countries, WCS is implementing an increasingly successful multi-regional campaign against illegal shark and ray fishing (with particular recent success in Indonesia).

World Wildlife Fund

WWF's Transparent Seas program seeks to ensure that seafood is fully traceable to legal sources. The project was launched in 2012 as part of WWF's Smart Fishing Initiative. It has staff based in Washington, Brussels, Maputo and Hamburg, intentionally focused on both "market" and "producer" countries, but especially in the US, EU and Africa. TSP is funded through the Smart Fishing Initiative's core budget, Oceans 5, the Moore Foundation, and the Norwegian Agency for Development Cooperation (for activities focused on Coastal East Africa).

The Smart Fishing Initiative has multiple dimensions, but at its heart is a desire to curtail IUU fishing and promote full supply chain traceability by improving catch documentation and effectively using satellite data. WWF's emphasis on AIS, satellite imagery, catch documentation, etc. is in many respects quite similar to that of Oceana and Pew. WWF is also working with a for-profit company, Navama, to create a new vessel tracking tool and data sharing platform similar to Oceana's. On the other hand, WWF's emphasis is distinct in that it is more narrowly applied to a handful of carefully selected and important commercial species, and to specific early adopters in the fishing industry. WWF has, for example, started a 5-year partnership with the Global Environment Facility and the Food and Agriculture Organization to make it mandatory that all tuna purse seine vessels have and use AIS and other electronic monitoring systems (e.g., cameras) to improve the accuracy of tuna catch data. WWF is also working with a fishing company in Fiji, Seaquest, on experiments with AIS transmitters and full satellite tracking transparency in a local long-line tuna fishery.

FOR-PROFIT COMPANIES WITH TECHNOLOGIES THAT CAN HELP END IUU FISHING

Aero Environment

Aero Environment is one of several companies that builds unmanned aircrafts/drones. Their product is usually utilized in support of military operations, but can also be used for ocean surveillance. Each aircraft costs about $100,000. While drones are a relatively new technology, at least in their applications for IUU fishing, they are often used to replace or, more often, complement aerial surveillance conducted by government air forces. WildAid has been in contact with Aero Environment about possible collaboration.

Archipelago Marine Research

Archipelago Marine Research works with government agencies and the fishing industry to monitor fishing effort in western Canada. In addition to at-sea observer services, Archipelago provides (a) the technology needed to improve dockside monitoring to verify catch, as well as (b) electronic monitoring at sea, using gear sensors, cameras, data collection software, etc.

DigitalGlobe

DigitalGlobe's Sea Star team provides data and imagery to, among many others, the US Coast Guard on those areas in the Pacific that are within U.S.'s EEZ. DigitalGlobe typically concentrates on the edges of EEZs, where illegal fishing is most likely to occur. The USCG uses DigitalGlobe's data to plan both air and naval surveillance to intercept violators (see www.geoeye.com).

Liquid Robotics

Liquid Robotics builds Wave Gliders—water borne drones that have the capacity to assist with a range of needs, from "Maritime Domain Awareness" to fish stock assessments.

Sea-Trak

Sea-Trak is a Florida-based company that "manufactures a line of self-housed underwater cameras that stream their video signal to the surface for viewing in real-time."

Shellcatch

Shellcatch works directly with fishermen to install the hardware boats need to collect data and verify what fish are caught where, using which methods. Shellcatch's verification system is based on the use of photos, video and telecommunication tools on boats and docks, and in processing plants. "Location data, images, weight information, and radio frequency codes along the supply chain enable Shellcatch's verification of seafood products."